CO_2 Sequestration Capabilities of Upper Cambrian-Lower Ordovician Formations in Southern Ohio

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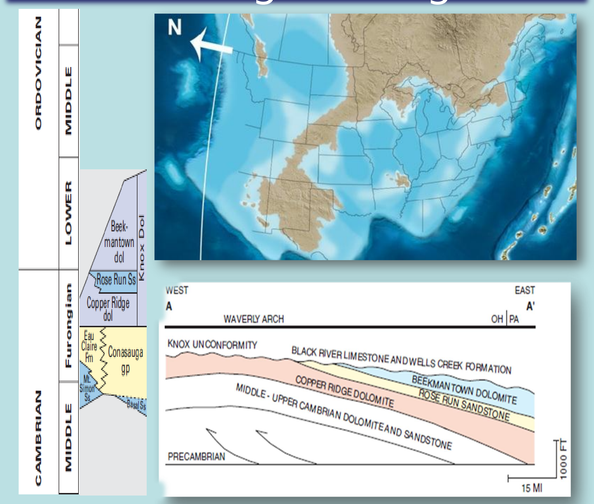
Introduction

Sequestration of supercritical CO_2 into porous and permeable formations beneath the Earth's surface can limit the amount of gaseous CO_2 emitted into the atmosphere as a byproduct of electricity production from coal-burning facilities. The Upper Cambrian-Lower Ordovician Knox Supergroup comprising the Copper Ridge Dolomite, Rose Run Sandstone, and Beekmantown Dolomite within the Aristech Well in Scioto County, Ohio is a possible target for CO_2 sequestration.

Objectives

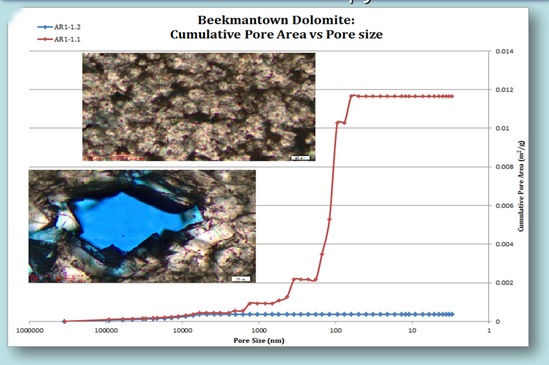
- Gain a sense of the stratigraphic, petrographic, structural, and bulk mineralogical characteristics of the Copper Ridge Dolomite, Rose Run Sandstone, and Beekmantown Dolomite that would ultimately allow or inhibit its use as a reservoir for the sequestration of supercritical CO_2.
- Identify ideal horizons for sequestration and understand vertical heterogeneity within formations based upon porosity, permeability, and pore characteristics.
- Identify intervals that would act as geologic seal that would prohibit the migration of sequestered CO_2 into overlying layers.
- Provide an estimate for the amount of supercritical CO_2 an identified horizon can sequester.

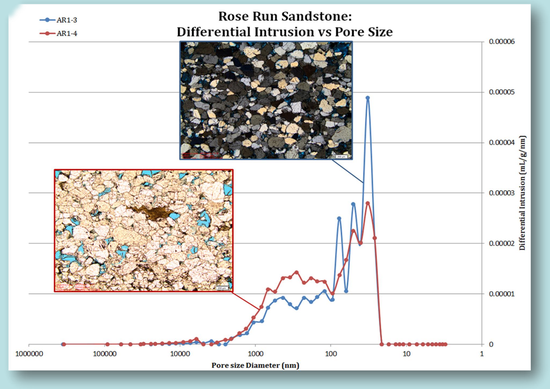
Geologic Setting

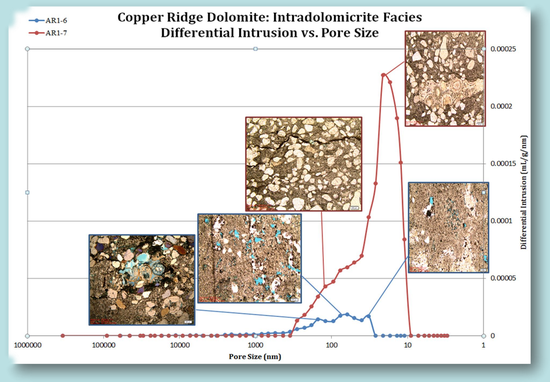


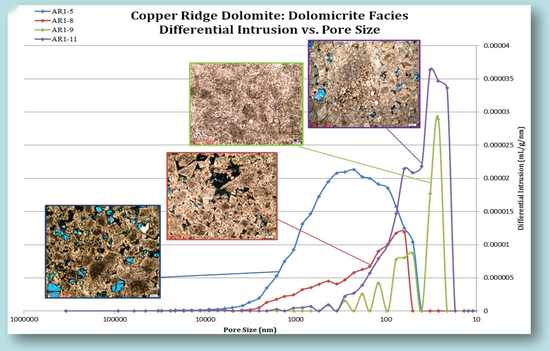
Results

Pore Size Distribution: Hg Porosimetry & Thin Section Microscopy Photos

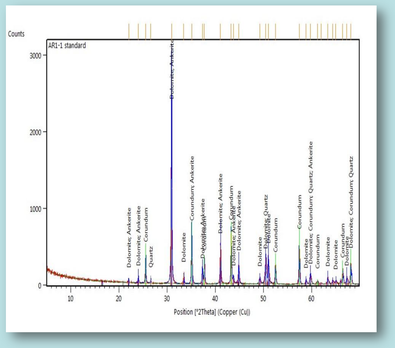


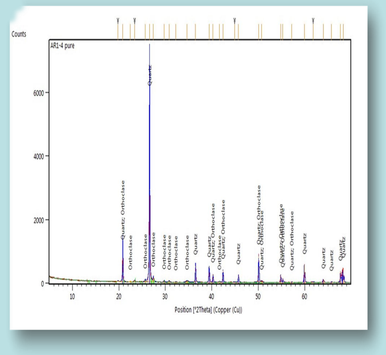


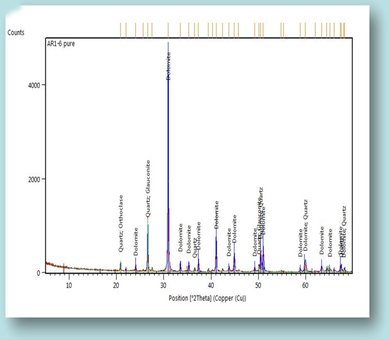




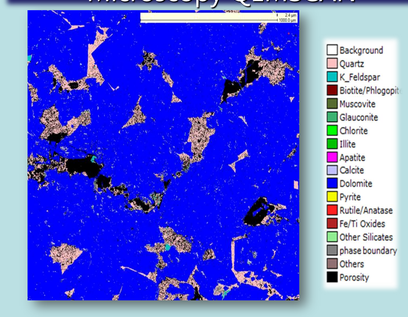
Bulk Mineralogy: X-ray Diffraction



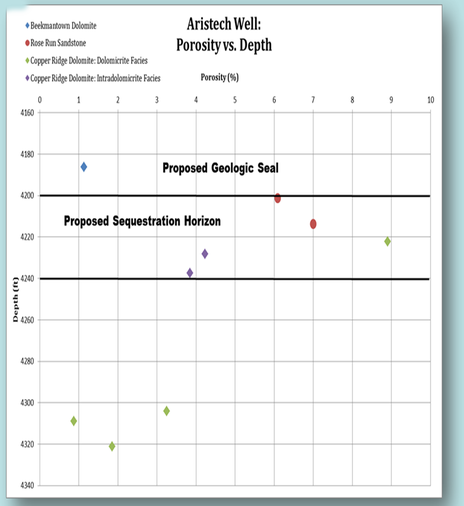


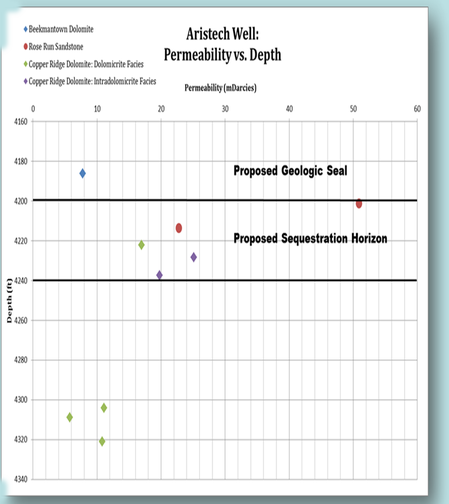


Pore Mineralogy: Scanning Electron Microscopy QEMSCAN



Sequestration Horizon & Geologic Seal: Porosity & Permeability





Horizon Capacity Estimation

Table 2. Summary of the CO_2 storage calculation and estimated amounts of CO_2 stored for several different injection scenarios

Formation thickness ft	Formation thickness cm	Radial distance CO_2 plume from well m	Radial distance CO_2 plume from well cm	Volume rock in cc	Density CO_2 g/cc	Porosity vol. fraction	Pore filling efficiency	CO_2 stored grams	CO_2 stored metric tons	CO_2 stored million metric tons
(a)		(b)		(c)	(d)	(e)	(f)			
40	1219.2	2000	200000	1.53209E+14	0.6077	0.06	1	5.58631E+12	5586308.787	5.586308787
40	1219.2	2000	200000	1.53209E+14	0.6077	0.06	0.75	4.18973E+12	4189731.59	4.18973159
40	1219.2	2000	200000	1.53209E+14	0.6077	0.06	0.5	2.79315E+12	2793154.393	2.793154393
40	1219.2	2000	200000	1.53209E+14	0.6077	0.06	0.25	1.39658E+12	1396577.197	1.396577197

(a) Sequestration horizon described above between 4200' and 4240'
(b) Assumes CO_2 plume spreads out 2 km in all directions from the injection well; diameter of plume is 4 km
(c) Volume = p x unit thickness x square of the radial distance
(d) CO_2 density calculated from the NIST on-line thermophysical calculator; assume 31.5°C and 76 bars pressure
(e) Pore fraction based on averages for these portions of the of the formation
(f) Assumes four different pore filling efficiencies - complete, three quarters, half, and one quarter filling

Conclusion

- A 40 foot interval encompassing the Upper Copper Ridge Dolomite and Rose Run Sandstone has been identified as a sequestration horizon due to ample porosity, permeability, and depth.
- The overlying Beekmantown Dolomite has very low porosity and permeability, and can serve as a geologic seal for the targeted horizon.
- Sequestration capacity estimations of the 40 foot horizon are between 1.396 and 5.586 metric tons of CO_2 depending on pore filling efficiency.
- Capacity estimation is the approximatly the annual CO_2 emissions from one coal-burning plant in adjacent counties along the Ohio River.

References

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- R. Blakey.-"North America during the Upper Cambrian" and "North America during the Early Ordovician" Paleogeographic maps. Northern Arizona University, 2007.
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- L.Wickstrom, E. Venteris, J. Harper, J. McDonald, E. Slucher, and 25 others. "Characterization of geologic sequestration opportunities in the MRCSP region." 2010.